Amendments to the Specification:

Please replace the paragraph beginning at page 18, line 15, with the following rewritten paragraph:

-- The three gyro 76d-76f input axes and three accelerometer 74d-74f input axes are preferably mutually orthogonal at the two 180° degree apart inner gimbal stops, and in between if the inner gimbals rotate in parallel, which can be accomplished by using one inner gimbal motor 40b that drives a gear chain which rotates ~~gyrocompasses~~ gyros 76d-76f and accelerometers 74d-74f stacked in an alternating configuration as shown in Fig. 8. --

Please replace the paragraph beginning at page 19, line 7, with the following rewritten paragraph:

-- A common method for dead reckoning kinematic navigation while drilling begins at step 130, Fig. 9, with obtaining a surveyed starting position of the borehole. Typically, the starting point of the borehole can be very well surveyed, even on the ocean bottom under a drilling platform. For example, global positioning system (GPS) satellite radio navigation equipment can be used to determine the drilling rig position, which is then projected to the starting point of the borehole. At step 132, the initial attitude of the navigation system is determined by gyrocompassing, in which the inner and outer gimbals may be rotated. At step 134, drilling is performed without obtaining additional sensor data. At step 136, gyrocompassing is performed when an additional segment of drill pipe is added. The inner and outer gimbals may be rotated again at step 136. At step 138, the location of the navigation system is determined by using dead reckoning kinematic navigation, which is performed by using attitude information from the ~~gyrocompasses~~ gyros obtained at steps 132 and 136 and the length of pipe (*L)* that was added to go from step 132 to step 136. The

segment of added drill pipe, which may be thirty feet or other lengths, is typically known or can be accurately measured. Alternatively, at step 140, the length of added drill pipe (L) can be obtained from an external source. At step 134, drilling is again performed without taking additional sensor data, and the process 136, etc. repeated. --

Please replace the paragraph beginning at page 21, line 2, with the following rewritten paragraph:

-- At step 162, gyrocompass data is collected while drill pipe is added to the drill string, and the gyrocompass data processing is done at step 164. The navigation while drilling position is Kalman filter updated at step 154 using the gyrocompass attitude information and the length L of the drill pipe._ L is measured in step 155, and the process is repeated at 156. --

Please replace the paragraph beginning at page 25, line 4, with the following rewritten paragraph:

-- (6) The outer gimbal is indexed or rotated −180° with data being collected during the rotation. It is important for calibration reasons that the outer gimbal be rotated −180° rather than +180°, even though the outer gimbal has complete rotary freedom. The effects of ~~gyrocompass~~ gyro bias and the Earth's rotation rate increases the magnitude of the integral of the gyrocompass output in a 180° rotation for one direction of rotation, and decreases this magnitude for the other direction of rotation. Thus even if not included exactly correctly in analyzing the data, the ~~gyrocompass~~ gyro scale factor calibration using the combined +180° and −180° slews is insensitive to these effects; --

Please replace the paragraph beginning at page 26, line 20, with the following rewritten paragraph:

-- If the gyrocompass information is used to determine azimuth, the assumption is preferably made that drill pipe 18 is stationary during the gyrocompass operation. Since the drill pipe is lifted off the bottom of the hole when a length of pipe is added, there could be some rotation of the drill pipe. The magnetometer data could be biased in its measurement of the Earth's magnetic field direction, but the change in magnetometer direction determination between the start and end of data taking at each gyrocompass position and across all four gyrocompass positions can be used to correct the ~~gyrocompass~~ gyro data and the accelerometer data for the rotation of the drill string during the gyrocompass operation, if there were a three-axis magnetometer in the system. --

Please replace the paragraph beginning at page 28, line 2, with the following rewritten paragraph:

-- Assume that the ~~gyrocompass~~ gyro and accelerometer input axes (IA) in the inner gimbal frame have the orientations

$$IA_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} , \quad IA_2 = \begin{bmatrix} 0 \\ \cos 45° \\ \sin 45° \end{bmatrix} , \quad IA_3 = \begin{bmatrix} 0 \\ -\sin 45° \\ \cos 45° \end{bmatrix} \qquad (2)$$

with IA_1 parallel to the outer gimbal axis at the cardinal gyrocompass positions and IA_2 and IA_3 at 45°angles to the inner gimbal axis. --

Please replace the paragraph beginning at page 28, line 9, with the following rewritten paragraph:

-- Let (ω_1, ω_2, ω_3) in the outer gimbal frame be the input to a sensor (Earth's rotation inertial angular velocity for a ~~gyrocompass~~ gyro, specific force or nongravitational acceleration reaction up to gravity pulling down for an accelerometer). --

Please delete the section heading at page 30, line 16.

Please add the following new section heading before the paragraph beginning at page 30, line 17.

-- Calibration of Gyro Scale Factors during Gyrocompass Slews --

Please replace the paragraph beginning at page 30, line 16, with the following rewritten paragraph:

-- Since the 180° slew between positions takes much less time than the gyrocompass dwells at the positions, the scale factor calibration can be less accurate than the gyrocompass calibration, offset however by having a larger rate input during the slew. Preferably, there are commensurate times for dwelling at a position and for slewing between positions. For instance, if the gyrocompass accuracy can measure the Earth's rotation vector direction to 10^{-3} radians, then the gyrocompass slew calibration should measure ~~gyrocompass~~ gyro scale factor to at least a part-in-a-thousand accuracy, unless the ~~gyrocompass~~ gyro scale factor were adequately stable from the surface calibration. Better scale factor accuracy is desirable for navigating while drilling, but the requirements while drilling can be ameliorated by outer gimbal ±360° carouseling relative to inertial space and by ±180° inner gimbal indexing during

drilling, and by external aids (such as from length of pipe going down the drill hole and from magnetometer data, as described below). –

Please replace the paragraph beginning at page 35, line 3, with the following rewritten paragraph:

-- Servoing the outer gimbal to the gyro integrated angle outputs plus the desired carousel angle eliminates the effect of gyro scale factor errors due to drill pipe rotation. The ±360° outer gimbal ~~initial~~ inertial carouseling and the ±180° inner gimbal indexing to average out the effect of gyro and accelerometer bias errors also unwinds the effect of ~~gyrocompass~~ gyro scale factor errors due to the carouseling and indexing (but not due to any small lateral angular motion of the drill pipe). If the carouseling were always in one direction, then the effect of gyro scale factor errors due to carouseling would build up continuously, which is why there is a periodic reversal of outer gimbal carousel direction. The existence of stops requires that there is reversal of inner gimbal indexing direction, which is also needed to unwind the effect of gyro scale factor errors due to the indexing motion. --